

What is Claimed is:

1           1.       A warming device for heating intravenous fluids to desired temperatures  
2 comprising:

3           a housing;

4           a fluid cassette removably securable within said device to receive fluid from an  
5 intravenous fluid line, wherein said fluid cassette includes fluid line tubing arranged to form a  
6 fluid flow path through said cassette;

7           a plurality of heating elements disposed within said housing to heat said fluid cassette,  
8 wherein said heating elements are positioned to facilitate insertion of said cassette between at  
9 least two heating elements;

10          at least one temperature sensor to measure at least one temperature within said housing;

11 and

12          a controller coupled to said at least one temperature sensor and said heating elements to  
13 control said heating elements in accordance with said at least one measured temperature.

1           2.       The warming device of claim 1, wherein said controller further enables said  
2 heating elements when said fluid cassette is secured within said device and disables said heating  
3 elements when said fluid cassette is absent from said device.

1           3.       The warming device of claim 1, wherein said housing further includes:

2           a cover including at least one of said heating elements to heat said fluid cassette;

3           a heater plate including at least one of said heating elements to receive and heat said fluid  
4 cassette; and

5           a base plate including a receiving surface to receive and retain said heater plate and said  
6 fluid cassette within said device.

1           4.       The warming device of claim 3, wherein:

2           said base plate further includes an electrically conductive post disposed on said receiving  
3 surface;

4           said fluid cassette further includes an electrically conductive contact disposed around a  
5 portion of said fluid line tubing;

6 each said cover heating element includes a contact plate; and  
 7 said controller controls said heating elements in response to said contact engaging said  
 8 conductive post and said contact plate.

1 5. The warming device of claim 1, wherein said fluid cassette includes inlet and  
 2 outlet terminals disposed proximate each other.

1 6. The warming device of claim 5, wherein said fluid cassette tubing includes an  
 2 inlet tubing section including said inlet terminal and an outlet tubing section including said outlet  
 3 terminal, and wherein said fluid cassette includes tubing sections extending adjacent each other  
 4 in a spiral configuration to form an annular section of said tubing cassette with said inlet and  
 5 outlet tubing sections extending tangentially from said annular section.

1 7. The warming device of claim 6, wherein said annular section includes an  
 2 intermediate section to direct fluid flow received from said inlet terminal in a reverse direction  
 3 through said annular section tubing sections toward said outlet terminal.

1 8. The warming device of claim 1, wherein said intravenous fluid line is connected  
 2 to a pre-heated container of fluid and said device is positioned toward a patient infusion site, and  
 3 wherein said controller controls said heating elements to heat said fluid to compensate for heat  
 4 loss due to exposure of said intravenous line fluid to an ambient environment during infusion.

1 9. The warming device of claim 1, wherein said fluid cassette tubing includes  
 2 concentric tubing sections each defining a path for fluid flow in a particular direction, and  
 3 wherein said fluid flow direction within each concentric tubing section is opposite to the fluid  
 4 flow direction within a concentric tubing section adjacent that section.

1 10. The warming device of claim 1, wherein said fluid cassette includes a fitting in  
 2 fluid communication with said fluid line tubing to measure temperature of fluid flowing within  
 3 said fluid cassette.

10016138 "131701  
T0222T" 02131001

1           11.     The warming device of claim 10, wherein said fitting includes a thermally  
2     conductive member in direct contact with fluid flowing within said fitting, and said housing  
3     further includes:

4           a temperature sensing probe suitably dimensioned to extend within said fitting and  
5     releasably engage said thermally conductive member to measure temperature of said fluid  
6     flowing within said cassette.

1           12.     The warming device of claim 1, wherein said controller selectively enables and  
2     disables said heating elements in accordance with a comparison of said at least one measured  
3     temperature with a desired fluid temperature.

1           13.     The warming device of claim 12, wherein said controller includes at least one  
2     input device to facilitate entry of said desired fluid temperature.

1           14.     The warming device of claim 1, wherein said housing further includes a heater  
2     plate including at least one of said heating elements to receive and heat said fluid cassette,  
3     wherein said at least one temperature sensor includes a first sensor disposed proximate said  
4     heater plate to measure a temperature of said heater plate and a second sensor disposed proximate  
5     said fluid cassette to measure a temperature of fluid flowing therein, and wherein said controller  
6     selectively enables and disables said heating elements in accordance with a comparison of said  
7     measured temperatures with a desired fluid temperature.

1           15.     The warming device of claim 1 further including a heat controller to control said  
2     heating elements to attain a predetermined temperature, wherein said heat controller is selectively  
3     disabled by said controller in accordance with said at least one measured temperature.

1           16.     The warming device of claim 1 further including a pivotable mount securable to  
2     a support structure to receive and place said warming device in a desired position.

10016128-121701

1           17.     A fluid cassette to receive fluid from an intravenous fluid line and facilitate  
2 heating of said fluid to a desired fluid temperature within an intravenous fluid warming device,  
3 said cassette comprising:

4           fluid line tubing including an inlet tubing portion with an inlet terminal to receive fluid  
5 into said cassette and an outlet tubing portion with an outlet terminal to release fluid from said  
6 cassette, said inlet and outlet terminals being securable to portions of said intravenous fluid line;

7           wherein said fluid line tubing further includes a plurality of tubing sections in fluid  
8 communication with said inlet and outlet tubing portions, each said tubing section defining a path  
9 for fluid flow in a particular direction, and wherein said fluid flow direction within each tubing  
10 section is opposite the fluid flow direction within a tubing section adjacent that section.

1           18.     The fluid cassette of claim 17, wherein said tubing sections are concentric and  
2 define a fluid cassette annular section, and said inlet and said outlet tubing portions extend  
3 tangentially from said annular section.

1           19.     The fluid cassette of claim 18, wherein said annular section includes an  
2 intermediate section to direct fluid flow received from said inlet terminal in a reverse direction  
3 through said annular section tubing sections toward said outlet terminal.

1           20.     The fluid cassette of claim 17 further including a conductive contact disposed  
2 about a portion of said fluid line tubing.

1           21.     The fluid cassette of claim 17 further including a fitting in fluid communication  
2 with said fluid line tubing to permit fluid to flow within said fitting, wherein said fitting receives  
3 a temperature sensor to measure temperature of said fluid flowing within said fluid cassette.

1           22.     The fluid cassette of claim 21, wherein said fitting includes a thermally conductive  
2 member disposed within said fitting and in direct contact with fluid flowing through said fitting,  
3 wherein said thermally conductive member receives said temperature sensor to measure  
4 temperature of said fluid flowing within said fluid cassette.

1           23.     The fluid cassette of claim 17 further including at least one engagement member  
2 to facilitate manipulation, insertion and removal of said fluid cassette within said warming  
3 device.

1           24.     In a warming device including a housing, a fluid cassette removably securable  
2 within said warming device, a plurality of heating elements, at least one temperature sensor and  
3 a controller, a method of heating intravenous fluids to desired temperatures comprising the steps  
4 of:

- 5           (a)     receiving fluid within said cassette from an intravenous fluid line, wherein said  
6 fluid cassette is disposed within said warming device between at least two of said heating  
7 elements and includes fluid line tubing arranged to form a fluid flow path through said cassette;  
8           (b)     heating said fluid cassette within said warming device via said heating elements;  
9           (c)     measuring at least one temperature within said housing; and  
10          (d)     controlling said heating elements in accordance with said at least one measured  
11 temperature.

1           25.     The method of claim 24, wherein step (d) further includes:

- 2           (d.1)    enabling said heating elements when said fluid cassette is secured within said  
3 device and disabling said heating elements when said fluid cassette is absent from said device.

1           26.     The method of claim 24, wherein said housing further includes a cover including  
2 at least one of said heating elements, a heater plate including at least one of said heating elements  
3 to receive and heat said fluid cassette and a base plate including a receiving surface to receive  
4 and retain said heater plate and said fluid cassette within said device, and step (d) further  
5 includes:

- 6           (d.1)    controlling said cover and heater plate heating elements in accordance with said  
7 at least one measured temperature to heat said fluid cassette.

1           27.     The method of claim 26, wherein said base plate further includes an electrically  
2 conductive post disposed on said receiving surface and said fluid cassette further includes an

3 electrically conductive contact disposed around a portion of said fluid line tubing, wherein each  
4 said cover heating element includes a contact plate, and step (d.1) further includes:

5 (d.1.1) controlling said heating elements in response to said contact engaging said  
6 conductive post and said contact plate.

1 28. The method of claim 24, wherein said fluid cassette includes inlet and outlet  
2 terminals disposed proximate each other, and step (a) further includes:

3 (a.1) receiving fluid from said intravenous fluid line via said inlet terminal; and

4 step (d) further includes:

5 (d.1) directing heated fluid from said fluid cassette to said intravenous line via said  
6 outlet terminal.

1 29. The method of claim 28, wherein said fluid cassette tubing includes an inlet tubing  
2 section including said inlet terminal and an outlet tubing section including said outlet terminal,  
3 wherein said fluid cassette includes tubing sections extending adjacent each other in a spiral  
4 configuration to form an annular section of said tubing cassette with said inlet and outlet tubing  
5 sections extending tangentially from said annular section, wherein said annular section includes  
6 an intermediate section, and step (a.1) further includes:

7 (a.1.1) directing fluid flow received from said inlet terminal in a reverse direction  
8 through said annular section tubing sections toward said outlet terminal via said intermediate  
9 section.

1 30. The method of claim 24, wherein said intravenous fluid line is connected to a pre-  
2 heated container of fluid and said device is positioned toward a patient infusion site, and step (d)  
3 further includes:

4 (d.1) controlling said heating elements to heat said fluid to compensate for heat loss due  
5 to exposure of said intravenous line fluid to an ambient environment during infusion.

1 31. The method of claim 24, wherein said fluid cassette tubing includes concentric  
2 tubing sections each defining a path for fluid flow in a particular direction, and step (a) further  
3 includes:

4 (a.1) directing fluid flow in a direction within each concentric tubing section that is  
5 opposite to the fluid flow direction within a concentric tubing section adjacent that section.

1 32. The method of claim 24, wherein said fluid cassette includes a fitting in fluid  
2 communication with said fluid line tubing, and step (c) further includes:

3 (c.1) measuring temperature of fluid flowing within said fluid cassette via said fitting.

1 33. The method of claim 32, wherein said fitting includes a thermally conductive  
2 member in direct contact with fluid flowing within said fitting and said housing further includes  
3 a temperature sensing probe suitably dimensioned to extend within said fitting and releasably  
4 engage said thermally conductive member, and step (c.1) further includes:

5 (c.1.1) measuring temperature of said fluid flowing within said cassette via said  
6 temperature sensing probe.

1 34. The method of claim 24, wherein step (d) further includes:

2 (d.1) selectively enabling and disabling said heating elements in accordance with a  
3 comparison of said at least one measured temperature with a desired fluid temperature.

1 35. The method of claim 34, wherein said controller includes at least one input device,  
2 and step (d.1) further includes:

3 (d.1.1) facilitating entry of said desired fluid temperature via said at least one input  
4 device.

1 36. The method of claim 24, wherein said housing further includes a heater plate  
2 including at least one of said heating elements to receive and heat said fluid cassette, wherein  
3 said at least one temperature sensor includes a first sensor disposed proximate said heater plate  
4 and a second sensor disposed proximate said fluid cassette, and step (c) further includes:

5 (c.1) measuring a temperature of said heater plate via said first sensor; and

6 (c.2) measuring a temperature of fluid flowing within said fluid cassette via said second  
7 sensor; and

8 step (d) further includes:

9 (d.1) selectively enabling and disabling said heating elements in accordance with a  
10 comparison of said measured temperatures with a desired fluid temperature.

1 37. The method of claim 24, wherein said warming device further includes a heat  
2 controller, and step (d) further includes:

3 (d.1) controlling said heating elements to attain a predetermined temperature via said  
4 heat controller, wherein said heat controller is selectively disabled by said controller in  
5 accordance with said at least one measured temperature.

1 38. The method of claim 24, wherein said warming device further includes a pivotable  
2 mount securable to a support structure, and step (a) further includes:

3 (a.1) receiving said warming device on said mount to facilitate placement of said  
4 warming device in a desired position.

1 39. A warming device for heating intravenous fluids to desired temperatures  
2 comprising:

3 a housing;

4 fluid flow means removably securable within said device for receiving fluid from an  
5 intravenous fluid line, wherein said fluid flow means includes fluid line tubing arranged to form  
6 a fluid flow path through said fluid flow means;

7 a plurality of thermal means disposed within said housing for heating said fluid flow  
8 means, wherein said thermal means are positioned to facilitate insertion of said fluid flow means  
9 between at least two thermal means;

10 temperature means for measuring at least one temperature within said housing; and

11 control means coupled to said temperature means and said thermal means for controlling  
12 said thermal means in accordance with said at least one measured temperature.

1 40. The warming device of claim 39, wherein said control means includes detection  
2 means for enabling said thermal means when said fluid flow means is secured within said device  
3 and disabling said thermal means when said fluid flow means is absent from said device.



100464391001

1           41.     The warming device of claim 39, wherein said housing further includes:  
2           a cover including at least one of said thermal means to heat said fluid cassette;  
3           heat applying means including at least one of said thermal means for receiving and  
4 heating said fluid flow means; and  
5           base means including a receiving surface for receiving and retaining said heat applying  
6 means and said fluid flow means within said device.

1           42.     The warming device of claim 41, wherein:  
2           said base means further includes an electrically conductive post disposed on said  
3 receiving surface;  
4           said fluid flow means further includes an electrically conductive contact disposed around  
5 a portion of said fluid line tubing;  
6           each said cover thermal means includes a contact plate; and  
7           said control means includes detection means for controlling said thermal means in  
8 response to said contact engaging said conductive post and said contact plate.

1           43.     The warming device of claim 39, wherein said fluid cassette includes inlet and  
2 outlet terminals disposed proximate each other.

1           44.     The warming device of claim 43, wherein said fluid flow means tubing includes  
2 an inlet tubing section including said inlet terminal and an outlet tubing section including said  
3 outlet terminal, wherein said fluid flow means includes tubing sections extending adjacent each  
4 other in a spiral configuration to form an annular section of said fluid flow means with said inlet  
5 and outlet tubing sections extending tangentially from said annular section.

1           45.     The warming device of claim 44, wherein said annular section includes an  
2 intermediate section to direct fluid flow received from said inlet terminal in a reverse direction  
3 through said annular section tubing sections toward said outlet terminal.

1           46.     The warming device of claim 39, wherein said fluid flow means tubing includes  
2 concentric tubing sections each defining a path for fluid flow in a particular direction, and

3 wherein said fluid flow direction within each concentric tubing section is opposite to the fluid  
4 flow direction within a concentric tubing section adjacent that section.

1 47. The warming device of claim 39, wherein said fluid flow means includes a fitting  
2 in fluid communication with said fluid line tubing to measure temperature of fluid flowing within  
3 said fluid flow means.

1 48. The warming device of claim 39, wherein said control means includes power  
2 means for selectively enabling and disabling said heating elements in accordance with a  
3 comparison of said at least one measured temperature with a desired fluid temperature.

1 49. The warming device of claim 39, wherein said housing further includes a heat  
2 applying means including at least one of said thermal means for receiving and heating said fluid  
3 flow means, wherein said temperature means includes first sensing means disposed proximate  
4 said heat applying means for measuring a temperature of said heat applying means and second  
5 sensing means disposed proximate said fluid flowing means for measuring a temperature of fluid  
6 flowing therein, and wherein said control means includes power means for selectively enabling  
7 and disabling said thermal means in accordance with a comparison of said measured  
8 temperatures with a desired fluid temperature.

1 50. The warming device of claim 39 further including heat control means for  
2 controlling said thermal means to attain a predetermined temperature, wherein said heat control  
3 means is selectively disabled by said control means in accordance with said at least one measured  
4 temperature.

1 51. A fluid cassette to receive fluid from an intravenous fluid line and facilitate  
2 heating of said fluid to a desired fluid temperature within an intravenous fluid warming device,  
3 said cassette comprising:

4 fluid flow means including an inlet portion with an inlet terminal to receive fluid into said  
5 cassette and an outlet portion with an outlet terminal to release fluid from said cassette, said inlet  
6 and outlet portions being securable to portions of said intravenous fluid line;

7 wherein said fluid flow means further includes a plurality of concentric sections in fluid  
8 communication with said inlet and outlet portions, each said concentric section defines a path for  
9 fluid flow in a particular direction, and wherein said fluid flow direction within each concentric  
10 section is opposite the fluid flow direction within a concentric section adjacent that section.

1 52. The fluid cassette of claim 51, wherein said concentric sections define a fluid  
2 cassette annular section, and said inlet and said outlet portions extend tangentially from said  
3 annular section.

1 53. The fluid cassette of claim 52, wherein said annular section includes an  
2 intermediate section to direct fluid flow received from said inlet terminal in a reverse direction  
3 through said annular section toward said outlet terminal.

1 54. The fluid cassette of claim 51 further including a conductive contact disposed  
2 about a portion of said fluid flow means.

1 55. The fluid cassette of claim 51 further including a fitting in fluid communication  
2 with said fluid flow means to permit fluid to flow within said fitting, wherein said fitting receives  
3 a temperature sensor to measure temperature of said fluid flowing within said fluid cassette.

1 56. The fluid cassette of claim 51 further including at least one engagement means  
2 for facilitating manipulation, insertion and removal of said fluid cassette within said warming  
3 device.

1 57. A fluid cassette to receive fluid from an intravenous fluid line and facilitate  
2 heating of said fluid to a desired fluid temperature within an intravenous fluid warming device,  
3 said cassette comprising:

4 a fluid conduit including an inlet portion with an inlet terminal to receive fluid into said  
5 cassette and an outlet portion with an outlet terminal to release fluid from said cassette, said inlet  
6 and outlet portions being securable to portions of said intravenous fluid line;

7 wherein said fluid conduit further includes a plurality of concentric sections in fluid  
8 communication with said inlet and outlet portions, each said concentric section defines a path for  
9 fluid flow in a particular direction, and wherein said fluid flow direction within each concentric  
10 section is opposite the fluid flow direction within a concentric section adjacent that section.

1 58. The fluid cassette of claim 57, wherein said concentric sections define a fluid  
2 cassette annular section, and said inlet and said outlet portions extend tangentially from said  
3 annular section.

1 59. The fluid cassette of claim 58, wherein said annular section includes an  
2 intermediate section to direct fluid flow received from said inlet terminal in a reverse direction  
3 through said annular section toward said outlet terminal.

1 60. The fluid cassette of claim 57 further including a conductive contact disposed  
2 about a portion of said fluid conduit.

1 61. The fluid cassette of claim 57 further including a fitting in fluid communication  
2 with said fluid conduit to permit fluid to flow within said fitting, wherein said fitting receives a  
3 temperature sensor to measure temperature of said fluid flowing within said fluid cassette.

1 62. The fluid cassette of claim 57 further including at least one engagement member  
2 to facilitate manipulation, insertion and removal of said fluid cassette within said warming  
3 device.